Initial Project Description Report

For Contract No.
DACA42-03-C-0040

Title:
Proton Exchange Membrane (PEM) Fuel Cell Demonstration Of Domestically Produced PEM Fuel Cells in Military Facilities

Submitted To:
US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY02

Submitted by:
DTE Energy Technologies, Inc.
37849 Interchange Drive
Farmington Hills, MI 48335

For Project Located At:
Selfridge Air National Guard Base, Michigan

November 3, 2003

Executive Summary

DTE Energy Technologies (Contractor) and Plug Power Inc. (Manufacturer) will install and operate two (2) CHP Fuel Cell Systems at the Selfridge Air National Guard Base, Michigan (Site Host) for a period of one year (Operating Period) with an option to extend the operation of one or more of the CHP Fuel Cell Systems to be offered the Customer at the end of the one year Operating Period.

The objective of this project (Project) is to plan, install, and operate CHP Systems in a military base environment, generating electricity and heat to support base facilities. The facility has been selected to best demonstrate CHP Systems use in military facilities in a configuration that offers technology transfer and demonstrates replicablity to similar facilities at other Department of Defense facilities. Analysis of energy savings is not a stated objective of this project.

Installation and commissioning of systems are expected to be complete in November, 2003. The systems are proposed for installation at the New Base Fire Station, Building 859. The new base Fire, Crash, and Rescue station at 28000 George Avenue in the final stage of completion, is a large facility that will provide Crash and Rescue capability for the Base and Airfield in the surrounding Macomb County Area. The mechanical systems at this facility are of an industrial nature.

Contractor will be responsible for providing the site planning, preparation, installation of CHP Systems, operations and maintenance support, and decommissioning of each of the CHP Systems installed. The Manufacturer will be responsible for CHP System manufacture, delivery, and technical support to the Contractor.

The 5kW CHP Systems, manufactured by Plug Power Inc. will incorporate combined heat and power capability to provide electricity, allow recovered waste heat from the CHP Systems to provide heat for heating or domestic hot water. The system will operate using natural gas as a fuel and in grid parallel mode to provide supplemental on-site power and usable heat to specific facilities. Additionally, the CHP Systems would incorporate standby capability to allow the units to supply power to segregated critical loads during periods of electric utility grid (Grid) outage.

The point of contact at Selfridge ANG is Mr. Michael Anderson who can be contacted at (586) 307-5402.

Table of Contents

1.0 Descriptive Title

Combined Heat and Power Fuel Cell System (CHP System) Demonstration at Selfridge Air National Guard Base, Michigan (East North Central Region)

2.0 Name, Address and Related Company Information

DTE Energy Technologies (Contractor)
37849 Interchange Drive
Farmington Hills, Michigan 48335

Data Universal Numbering System (DUNS) Number: 111996430
Commercial and Government Entity (CAGE) Code: 1UM49
Taxpayer Identification Number (TIN): 383394820

DTE Energy Technologies, a wholly owned subsidiary of DTE Energy, whose primary business focus is establishing a leadership position in the emerging distributed generation industry. Contractor is uniquely positioned to offer one-stop sales, engineering, and service to energy customers using a best of breed portfolio of new technology products and control services.

3.0 Production Capability of the Manufacturer

CHP Systems are manufactured at Plug Power's Latham, New York manufacturing facility. This facility, which opened in February 2000, is comprised of 50,000 square feet of dedicated production and production test facilities. Manufacturer employs approximately 100 personnel in its production areas. The production processes are designed around the principles of Lean Manufacturing, and use the Toyota Production System as a model. As such, planning and production is via a "pull system" that is, systems are produced only as orders pull demand for product through the production system. Lead-time for delivery is between eight (8) and twelve (12) weeks for large orders, smaller orders (less than ten) can be fulfilled immediately. Current production capability allows for the manufacture of approximately five (5) units per week with the ability to significantly increase this rate.

Manufacturer agrees to provide a minimum of two (2) CHP Systems to support this Program and to provide warranty and technical support to Contractor to support the operation of the CHP Systems as specified in this proposal.

Plug Power contact information:
Mr. Scott Wilshire
Director, Marketing Engagement
968 Albany Shaker Road
Lathum, NY 12110

Tele: 518.782.7700 ext. 1338
Email: scott_wilshire@plugpower.com

4.0 Principal Investigator(s)

Ted Bregar
Director, Business Development

DTE Energy Technologies, Inc.

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Fax: 248.427.2265
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5.0 Authorized Negotiator(s)

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Peter Gibson
Vice President, Sales
DTE Energy Technologies, Inc.
Tele: 248.427.2274
Fax: 248.427.2265
Email: gibsonp@dteenergy.com

6.0 Past Relevant Performance Information

DTE Energy Technologies (Contractor)

Detroit Metropolitan Wayne County Airport
Romulus, Michigan 48242
POC: Mr. Robert Murphy, (734) 942-3556
Project Title: Midfield Terminal 17MW Co-generation Project
Contract Identification Number: N/A

- Contract Completion Date: February, 2002
- Contract Amount: $17M

Ann Arbor News
340 E. Huron Street
Ann Arbor, Michigan 48106
POC: Mr. David Sharp, (734) 994-6804
Project Title: 2MW Standby Generation
Contract Identification Number: N/A

- Contract Completion Date: November, 2001
- Contract Amount: $1.5M

Michigan Public Services Commission
Commission Operations Division
6545 Mercantile Way
Lansing, MI 48909
POC: Dr. Nicholas Nwabueze, 517.241.6137
Project Title: Michigan Energy Efficiency Grant PSC-03-02
Contract Identification Number: PSC-03-02

- Contract Completion Date: September, 2003

- Contract Amount: $395,000

Plug Power Inc. (Manufacturer)

Long Island Power Authority
333 Earle Ovington Blvd
Suite 403
Uniondale, NY 11553
POC: Mr. Daniel Zaweski, (516) 719-9886
Project Title: Fuel Cell Demonstration Program
Contract Identification Number: N/A

- Contract Award Date: May 15, 2001
- Contract Amount: $7M
- Contract Award Date: February 22, 2002
- Contract Amount: $3.6M

New York State Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399
POC: Mr. James Foster, (518) 862-1090 x3376
Project Title: Fuel Cell Demonstration Project
Contract Identification Number: No. 4870 - ERTER - BA - 99

- Contract Award Date: January 25, 1999
- Contract Amount: $3M

National Fuel Gas Corporation
10 Lafayette Square
Buffalo, NY 14203
POC: Mr. Rob Eck, (716) 857-7711
Project Title: Residential Fuel Cell Demonstration Project
Contract Identification Number: N/A

- Contract Award Date: February, 2002
- Contract Amount: $200K

7.0 Host Facility Information

Selfridge Air National Guard Base is a joint military community located 22 miles east of Warren, Michigan, on Lake St. Claire. As the last base in Michigan, Selfridge supports a population of 50,000 people. Selfridge Air National Guard Base is defined as the Site Host Facility. The base is home to both U.S. Air Force and U.S. Army garrisons. The electricity provider for Selfridge is Detroit Edision, natural gas is provided by CMS Energy.

Appendix 1 contains pictures of the facility's main gate.

8.0 Fuel Cell Site Information

The new base Fire, Crash, and Rescue station at 28000 George Avenue in the final stage of completion, is a large facility that will provide Crash and Rescue capability for the Base and Airfield in the surrounding Macomb County Area. Contractor in conjunction with Air Force Site Host Facility personnel has identified the new Fire and Rescue Building 859 as the site for this project. The systems will be installed outdoors in a plaza situated adjacent to the building. The mechanical systems at this facility are of an industrial nature.

The new Fire Station is an excellent site for the following reasons: the advanced stage of building completion fits the Q3 '02 timing of this CHP Fuel Cell project; the building's electrical and hot water (thermal) requirements can fully utilize the continuous output of the fuel cells, and the high profile focus of this attractive new fire station serves as an ideal showcase for the emerging fuel cell technology.

Appendix 2 contains photographs of the fuel cell and site.

Plug Power Inc. is the manufacturer of the 5kW Combined Heat and Power Fuel Cell Systems (CHP Systems) which are certified for safety by CSA International. The CSA certification is for outdoor operation in accordance with the relevant codes and standards and is applicable to the overall unit. The power conditioning system is UL Listed. Product specifications and compliance information are shown in Tables 1 and 2 respectively.

Table 1: Product Specifications

Attribute	**Specification**
Type of Fuel Cell	Proton Exchange Membrane (PEM)
Model	SU1
Power Output	2.5 - 5 kW
Manufacturer	Plug Power Inc., Latham, New York
Unit Size	Base Unit with integral skid: 84"L x 32"W x 68 1/4"H (excludes 22" exhaust stack)
Installation Location	Outdoor
Grid Parallel	Yes (Standby capability rated at 4.5kW)
Remote monitoring capability	Via phone line or RS232
Output Voltage	120 VAC @ 60 Hz. Can be adapted to other standard voltages such as 240V or 480V.
Certification	Integrated System CSA International Certified; Inverter UL Listed
Waste Heat Utilization	Yes. System Efficiency will vary depending on external Cogeneration Loop temperature and flow rate. Based on the published overall system efficiencies of 50%, 55%, and 50%, the minimum thermal energy output of 2308W, 3840W, and 5106W should be expected for 2.5, 4, and 5KW setpoints respectively.
Recovered heat output	▪ Heat Recovery Liquid Operating Pressure Range 0 – 50 PSIG ▪ Heat Recovery Liquid Temperature Range 32°F to 130°F ▪ Expected Heat Recovery Liquid Flow Range 0 to 10 GPM ▪ Customer Fluid Connections to Fuel Cell Inlet - ¾" NPT Female Outlet - ¾" NPT Female
Electric only efficiency	26% @ 2.5 kW 25% @ 4.0 kW

Attribute	Specification
	23.5% @ 5 kW
Overall efficiency (with CHP)	50% @ 2.5 kW 55% @ 4.0 kW 50% @ 5 kW
Fuel capability	Natural gas
Fuel use	Gas requirements are as follows: minimum of 70 standard liters per minute ("SLM") of natural gas. Natural gas constituency must be >90% methane and sulfur content no greater than 15 ppm on a yearly average basis. Projected fuel consumption (in million BTUs) at rated electric power, and electrical efficiency at peak and part-load conditions Power (kW) Efficiency (%) Fuel use (BTUs/hour) 2.5 26 31,600 BTUs 4 25 54,600 BTUs 5 23.5 97,500 BTUs Fresh water supply is required. System requires approximately 0.4 gph, 0.6 gph, and 0.8 gph of fresh water at 2.5, 4, and 5 kW power levels, respectively.

Table 2: Compliance to Applicable Codes and Standards

Code or Standard	Compliance
ANSI Z21.83, Standard for Fuel Cell Power Plants (fuel cell performance and safety)	CHP System has been evaluated and certified by CSA International to this standard.
NFPA 853, Installation Standard for Fuel Cell Power Plants >50 kW (fuel cells near buildings)	This standard is applicable to 50 kW and larger systems. It is not applicable to CHP Systems.
NFPA 70, National Electric Code (installation of electrical equipment)	CHP Systems will be installed in accordance with Article 692, Fuel Cell Systems, to be published in the 2002 National Electrical Code.
UL 1741, Inverters, Converters and Controllers for Use in Independent Power Systems & IEEE 1547, Standard for Interconnected Distributed Resources with Electric Power Systems	Power conversion equipment is UL Listed to this standard. IEEE 1547 - Draft standard is undergoing extensive revision by the 1547 Committee; CHP System complies with the technical requirements of the draft versions, and additionally, has been approved for interconnection under the New York State Standardized Interconnection Requirements.

The 5kW CHP Systems, manufactured by Plug Power Inc. will incorporate combined heat and power capability to provide electricity, allow recovered waste heat from the CHP Systems to provide heat for heating or domestic hot water. Cogeneration heat is only available when the system is producing electricity. The system will operate using natural gas as a fuel and in grid parallel mode to provide supplemental on-site power and usable heat to specific facilities. Additionally, the CHP Systems would incorporate standby capability to allow the units to supply power to segregated critical loads during periods of electric utility grid (Grid) outage. The CHP

System provides cogeneration capability and is capable of running in either a simple cycle electric or cogeneration mode.

There were no significant permitting issues involved with siting the fuel cell either from the EPA or local utilities.

Appendix 3 contains Installation photographs, and engineering design drawings.

9.0 Electrical System

The fuel cell electrical system consists of two 5kVA fuel cells connected directly to the building's electrical grid through an existing power panel. Each fuel cell feeds into this panel through a single pole 50A circuit breaker. Any fuel cell power not used at this power panel is consumed upstream in the building's electrical system.

The building served by the fuel cells is a fire rescue facility with a generator that will service the entire facility in the event of a power outage. The customer specified that, due to safety concerns, they do not want the fuel cell to export power to the grid while the generator services the facility. With this in mind, a relay scheme was installed to accommodate this requirement. While the fuel cell is capable of operating independent of the utility grid, because of the customer's requirements, the fuel cell will not export power if the utility grid is lost.

Appendix 4 contains engineering design drawings.

10.0 Thermal Recovery System

The thermal recovery system is designed for continuous operation to supplement the present heating system. During normal building procedures the boilers are used to offset building envelope as well as to provide reheat for each occupied space. The fuel cell thermal recovery feature effectively provides supplementary thermal heat for the boiler system.

With both fuel cells in full operation the thermal recovery system produces 54,000 BTU of heat per hour, 100% of the fuel cells thermal recovery heat can be utilized on a continuous basis.

The system consists of two fuel cells that preheat water entering the building's boiler. There are glycol loops on the fuel cell side, and a water loop on the boiler side of a heat exchanger. The fuel cell loop is connected to a common header loop filled with 35% propylene glycol allowing for year round operation. The units are piped back to the mechanical room and pumped through the primary side of a plate and frame heat exchanger. The secondary side of the heat exchanger is piped into the inlet side of the existing boiler system. Circulation pumps are included as necessary. The system also includes solenoids and an aqua stat to stop the circulation of the thermal recovery system in the event the building's system reaches a temperature such that thermal recovery is not required.

Appendix 5 contains engineering design drawings.

11.0 Data Acquisition System

Two systems acquire data from the fuel cell. The first is an on board Mitsubishi processor that is in the System and Reformer Controller (SARC). This continually monitors the unit for E-stop and over 100 different conditions as well as any abnormalities. E- Stop condition will exist for the following conditions. Cabinet flow switch FS1, cathode air flow falls low, high gas pressure, gas leaks methane FG1 and hydrogen HS1 , cooling loss to electronic controls PRES2, loss of communication of the SARC and Inverter, Various system and high cabinet temperatures and humidifier overpressure. If any of these conditions or any other anomalies exist the unit will immediately shut down. Upon shutdown 15 minutes of data is stored and sent to Plug Power for analysis via the on board modem. An E-mail is than generated and sent from Plug Power to the authorized service personnel.

The second data acquisition is the System Operation Center (SOC). SOC remotely monitors and controls distributed assets via the internet, public switch networks and private circuits. There are 3 levels of SOC operation available: asset monitoring only, monitoring / dispatching and, monitoring / dispatching / energy trading. SOC hardware is Commercial Off The Shelf (COTS) with the software using Extensible Mark-up language (XML) Remote Procedure Call (RPC). In this particular application SOC monitors the fuel cell grid voltage, current, frequency and kilowatts along with the following; error codes, battery amps, battery voltage, battery temperature and system state. Data can be viewed from the internet and is monitored daily by a SOC operator. SOC will send a text message or e-mail or a phone call if the unit shuts down.

12.0 Economic Analysis

Although this project is being performed for the purposes of technology demonstration, an analysis was run to determine the economic value of the project. The fuel cell system is installed with hot water heat recovery systems.

The analysis reflects the actual operating configuration and conditions of the project. The hot water heat recovery systems will increase the total system efficiency and will save some energy and therefore operating costs money for the facility.

Following data is used to calculate both electric & thermal energy & costs savings.

Electric:

- Electric output = 5 kW, each
- Number of units = 2
- Operating hours = 8,760 hr/yr
- Electric costs = $0.07/kWh (Assuming Primary D6 rate)

Gas:

- Gas input for Fuel cell = 105 CFH, each
- Gas Costs = $5.00/MMbtu (Assuming MichCon Transportation rate)

Hot Water:

- Secondary (Load side) Flow = 5.6 gpm
- Water Temperature IN = 160 F
- Water Temperature OUT = 180 F

Savings Calculations:

I. Electric Savings ($/yr) = [(Electric output)*(No. of units)*(hr/yr)*($/kWh)]
= (5 kW)*(2)*(8,760 hr/yr)*($0.07/kWh)
= $6,132/yr

II. Gas Savings ($/yr) = (500)*(gpm)*(no. of units)*(Tout – Tin)*(hr/yr)*($/MMBtu)
= (500)*(5.6)*(2)*(180 – 160)*(8760)*($5.00/MMBtu)/10^6
= $4,905/yr

III. Gas Costs to Operate Fuel Cells = (CFH/unit)*(no. of units)*(hr/yr)*(1/1000 Btu/CF)*($/MMbtu)
= (105)*(2)*(8,760)*(1/1000)*($5.00/MMbtu)
= $9,198/yr

NET Savings ($/yr) = (Electric Savings) + (Gas Savings) – (Gas Costs to operate)
= ($6,132/yr) + ($4,905/yr) – ($9,198/yr)
= **$1,839/yr**

13.0 Kickoff Meeting Information

The kickoff meeting for this project took place on June 5, 2003 at Selfridge ANG Base. The following agenda was discussed:

- Job Schedule Overview
  - Engineering
  - Permitting
  - Site work
  - Fuel cell assembly and installation
  - Target completion date
- Engineering
  - Preference of company
  - Suggested company
- Construction
  - Civil
  - Mechanical
  - Electrical
  - SOC / Phone / Data
- Site Information
  - Contacts
  - Security
- Shut-downs
  - Notification
  - Procedures

No significant issues / hurdles were encountered during the meeting

Appendix 6 contains the listing of attendees to the kick-off meeting.

14.0 Status/Timeline

Appendix 7 contains the top level schedule for the project.

Appendix 1

Photographs Of Facility Main Gate

Appendix 2

Photographs Of Fuel Cell And Site

Appendix 3

Installation Photographs

Appendix 4

Electrical Design Drawings and Photographs

Appendix 5

Thermal Design Drawings and Photographs

Appendix 6

List Of Kickoff Meeting Attendees

Appendix 7

Project Schedule